# Space Weather Technical Forecast

Issued on Sunday, 08 October 2023 at 13:26 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Chance of M-class flares throughout. Chance of G1/Minor Storm intervals 09-11 Oct.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar Activity is Moderate with an isolated M1.7 flare observed at 07/1807 UTC, from AR3460 in the southeast. Nine sunspot regions feature on the visible disc with two unnumbered. AR3451 in the northwest is the largest and most magnetically complex, with a delta region in it's central portion. AR3452 is smaller and continues to decay. AR3460 in the southeast is the next most complex region, now with beta-gamma magnetic complexity and showing signs of growth and proliferation of intermediate spots. This spot is responsible for a C5 flare at 08/0339 UTC, which gave a partial halo CME that likely has an Earth directed component. The remaining regions all appear to be small and mostly simple at present.

**Solar Wind / Geomagnetic Activity:** Solar winds as observed at L1 by ACE have been at slow-ambient levels, around 330 km/s. The solar wind density was below average. Total magnetic field strength has been weak. The north-south component varied weakly between +5/-5 nT. Phi angle was initially positive (away from the Sun) with a switch to mostly negative (toward the Sun) from 08/0500 UTC. Geomagnetic activity has been Quiet (Kp 0-2).

**Energetic Particles / Solar Radiation:** GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was at background to moderate levels. Associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold with a mostly flat trend. The observation at 08/0000 UTC was 1.16e7 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Solar activity is expected to remain at Moderate levels, with the greatest chance of a further Moderate level flare probably coming from AR3451 and AR3452 in the northwest of the disc, and perhaps also from the newly emerging region AR3460 in the southeast, which has the rather unusual magnetic structure which favours enhanced flare activity.

**Solar Wind / Geomagnetic Activity:** Two potential CME's feature in the forecast. One from 05 Oct and one from 08 Oct, potentially arriving day 2 (09 Oct) and day 4 (11 Oct) respectively. Solar winds are expected to remain at slow-ambient levels until the High Speed Streams (HSS) of CH57 and CH58 arrive at Earth later on day 2 (09 Oct) and into day 3 (10 Oct), with solar winds perhaps reaching elevated levels.

Geomagnetic activity is expected to be Quiet to Unsettled initially. Unsettled to Active geomagnetic activity is then likely to predominate from day 2 onward (09-11 Oct), with a daily chance G1/Minor storm periods due to either CME impacts or CH HSS enhancements.

**Energetic Particles / Solar Radiation:** High energy (greater than 10 MeV) proton flux is most likely to remain at background levels, with a very low risk of enhancements, mainly from AR3451. High energy electron flux (greater than 2MeV) is forecast to be at background to moderate levels throughout. Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

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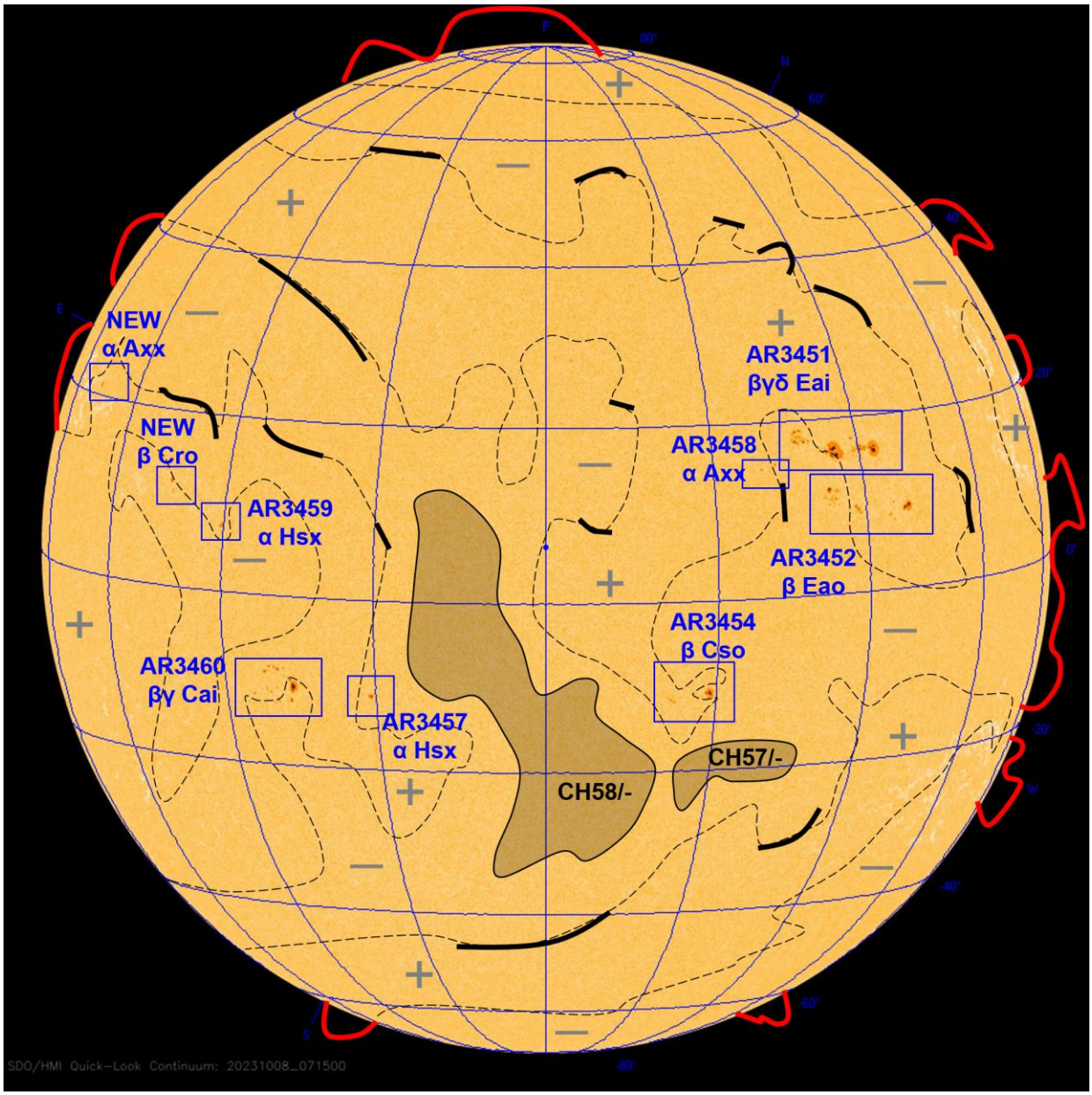
**Figure 1. Solar Analysis Valid 08/0800 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

A CME which left the Sun around 05/1930 UTC is mostly directed away from Earth. Whilst there may be some shock component arriving on Day 2 (09 Oct), any impacts from this are expected to be minor. A further CME which left the sun on 08 Oct, associated with the C5 flare of AR3460 at 08/0339 UTC, is expected to arrive at Earth late on 11 or early 12 Oct. This brings a chance of G1/Minor storms intervals.

Solar winds are expected to remain at slow-ambient levels until the High Speed Streams (HSS) of CH57/- shortly followed by CH58/- arrive at Earth later on Day 2 (09 Oct) and into Day 3 (10 Oct), with solar winds perhaps reaching elevated levels. However, these are negative polarity coronal holes, which are not favoured for significant geomagnetic response at this time of year.

Geomagnetic activity is expected to be Quiet to Unsettled initially. Unsettled to Active geomagnetic activity is then likely to predominate from day 2 onward (09-11 Oct), with a daily chance G1/Minor storm periods due to either CME impacts or CH HSS enhancements.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 1 | 30 | 30 | 30 |
| Strong | G3 | No | 1 | 2 | 2 | 2 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 06/0205 | Partial Halo | Large filament eruption | NW limb | 680 | 09 Oct | Likely miss, perhaps chance of shock. |
| 08/1435 | Parial | C5 flare | AR3460 | 460 km/s | 11/2100 +/- 12 hours. | Moderate confidence, though CH HSS may deflect some material. |

**Figure 2: Latest ENLIL**

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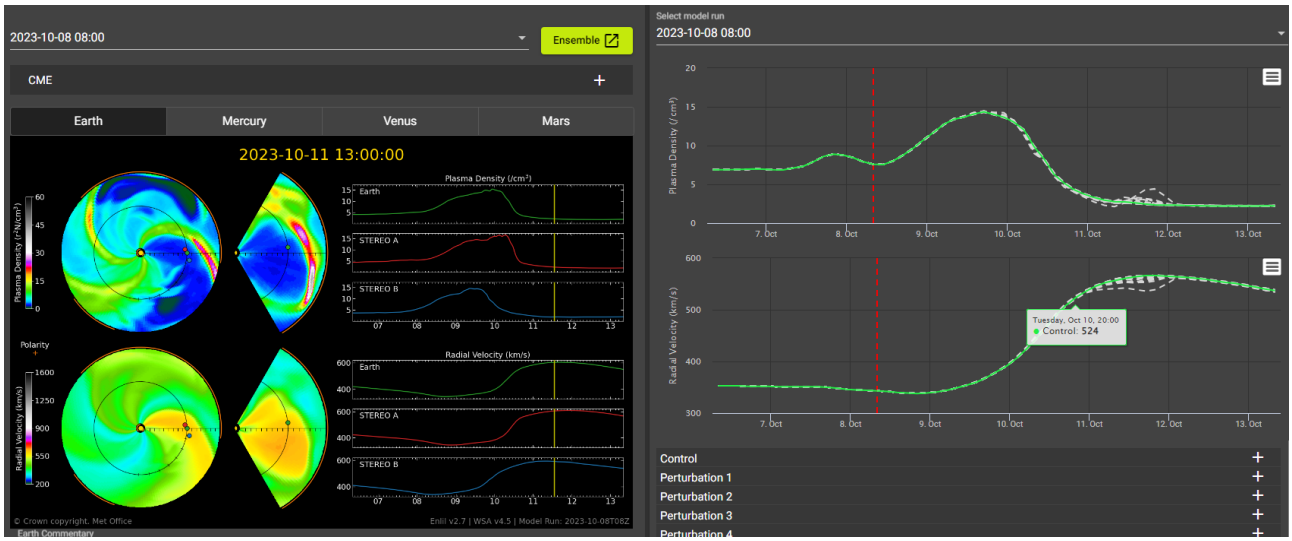


## Radio Blackouts - X-Ray Flares:

Nine sunspot regions feature on the visible disc with two unnumbered. AR3451 and AR3452 in the northwest are the two largest regions. AR3451 continues to develop, showing growth in areal extent in recent hours, and with a delta region in it's central portion. AR3452 is smaller and continues to decay. AR3460 in the southeast is the next most complex region, now with beta-gamma magnetic complexity and showing signs of growth and proliferation of intermediate spots. The yet unnumbered region in northeast is north-south magnetically aligned, though appears small at present. The remaining regions all appear to be small and mostly simple at present. Solar activity is Moderate with a M-class flare from the emerging active region 3460 in the southeast, peaking at M1.7 at 07/1806UTC. Low to moderate solar activity is expected to continue, with a 50% chance of further M-class flares.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | No | 50 | 50 | 50 | 50 |
| Very Active | R3 to R5 X Class | No | 5 | 5 | 5 | 5 |

**Figure 3: 24 hour Xray trace.**

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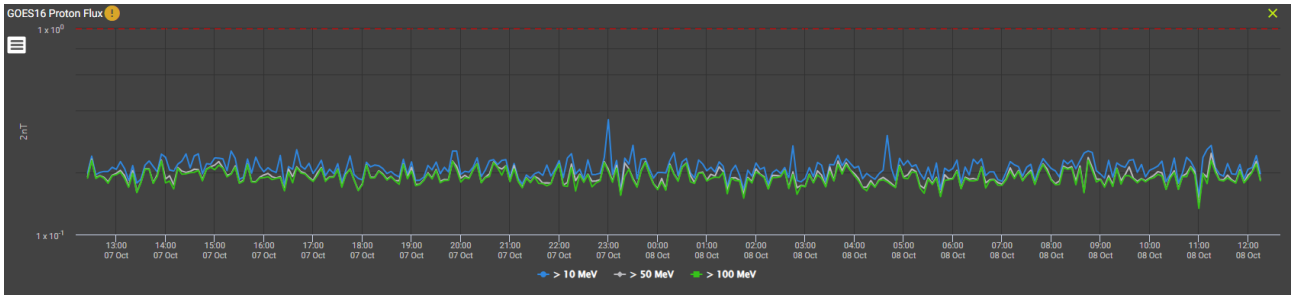
## Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at background levels. The main risk of any enhancement is from AR3451, which is comfortably in the western hemisphere, which offers an enhanced risk.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 5 | 5 | 5 | 5 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

**Figure 4: 24 hour proton flux**

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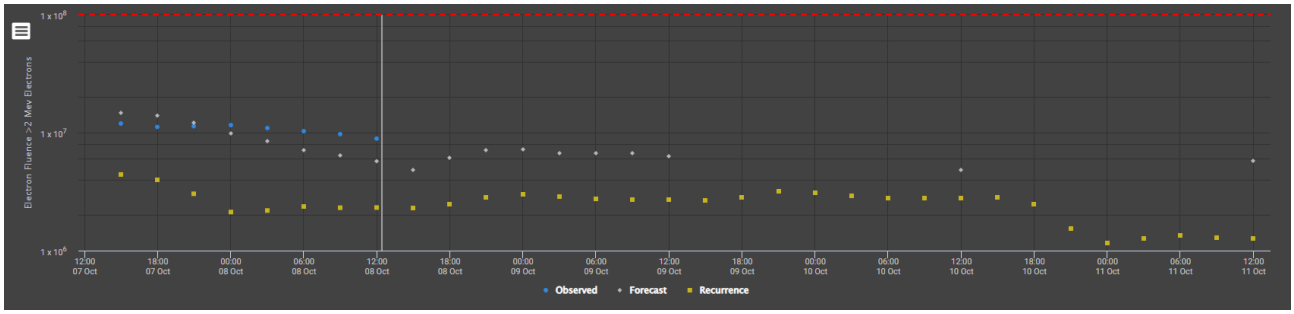
## High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES16 has achieved moderate levels at the diurnal maximum in recent days. This is expected to continue through the period, with a slight chance of briefly reaching High levels during the diurnal max. The potential CME shock and HSS effects on Day 2 (09 Oct) could potentially lead to a degree of temporary suppression in the flux but activity is likely to be raised again for the end of this four day guidance period..

Electron fluence is forecast to be well below the Active (1e8 integrated pfu) level throughout. MOSWOC REFM output is offering reasonable guidance with a mostly flat trend, held below Active threshold level, but levels appear to be a little too low.

| GEO Electron Environment<br>Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 1 | 1 | 1 | 5 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

**Figure 5: REFM**

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